Automating Attendance Records with Haar Cascade and ResNet

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An automated attendance system tracks attendance electronically, typically using facial recognition technology, streamlining record-keeping processes. This work presents a novel approach to attendance management utilizing advanced technologies such as the ResNet-50 algorithm and Haar Cascade for facial detection. The system leverages ResNet's deep learning architecture to extract unique facial features, combined with Haar Cascade's robust facial detection capabilities, resulting in efficient and accurate attendance recording and storing the attendance of all the previous days in an SQLite database. From the experimental results, it has been noted that even under occlusion situations, this model can identify nearly every face and 90% accuracy in the low lighting and occlusion conditions.

CCS CONCEPTS

- Computing methodologies ~ Computer graphics ~ Shape modeling ~ Shape analysis
- Computing methodologies ~ Machine learning ~ Machine learning approaches ~ Neural networks

Additional Keywords and Phrases: Dlib, Haar Cascade, Resnet-50, SQLite

1 INTRODUCTION

In this digital era, most institutions prefer to digitize the attendance system rather than wasting their time manually entering attendance. The attendance system has applications in various sectors. In educational institutions, it ensures accurate and automated student attendance tracking, minimizes the risk of proxy attendance, and provides real-time insights for educators and administrators. In corporate settings, the system enhances workforce management by automating attendance recording, improving security through biometric authentication, and facilitating seamless integration with existing HR systems. Additionally, the technology proves valuable in secure access control scenarios, such as restricted areas within organizations or government facilities, where real-time monitoring and accurate identification are critical.[1]. This approach offers an innovative way for streamlining the attendance management procedure. With the combination of ResNet's potent deep learning architecture and Haar Cascade's strong facial detection capabilities, this system provides unmatched efficiency and accuracy in person identification. By using the above-mentioned technologies, the system records attendance data quickly and accurately, avoiding the need of manual entry or a card-based entry. Not only does this solution enhances the overall efficacy of the attendance tracking system but also is a major furtherance towards smooth incorporation of automated organizational operations.[2]

The primary driving force behind the development of an image processing-based Real-time Attendance Marking System is the need to overcome the limitations of conventional attendance monitoring techniques. Real- time discernment is not possible in Manual attendance systems ,they often are time consuming and liable to errors. The general approach follows the steps of attainment of facial features using the webcam or cameras emphasizing optimal lighting conditions. The acquired images undergo preprocessing steps. Then, Face detection algorithms, such as haar cascades or CNNs, are employed to extract facial regions. Key facial features are extracted and matched with an existing database. The attendance status is determined based on recognition results and stored.

This work aims to improve and revolutionize the way attendance is managed by leveraging advanced technologies such as the resnet-50 algorithm. The photos of the students who are present in class are first gathered, and the facial landmarks found using the Haar Cascade algorithm are then used as input to the ResNet algorithm to train the model. The recorded attendance is then stored in a SQLite database.

2 LITERATURE SURVEY

This section explains the key research that has already been performed on the facial attendance system and is outlined as follows:

S. Matilda et al. created a face detection and recognition model based on the Viola-Jones Haar cascade technique. The model maps each student's unique facial traits and obtains their details using a trained dataset. The model has an accuracy of 99.38% and provides clear face recognition results which can be stored in an Excel sheet.[3]

Ashesh Kumar et al. suggest an automatic attendance system that makes use of dlib for facial identification and OpenCV for frame extraction. With a faster reaction time, it can identify more faces from a single frame with greater accuracy. The system facilitates students and teachers with a dashboard so that they can view their respective attendance reports.[4]

Karthikeyan et al. proposed a system that uses the Local Binary Pattern Histogram (LBPH) algorithm with the Viola-Jones Face identification Technique for face identification and recognition. The video's frames are captured by the system, which then turns them into numbers. The human faces for the attendance record are then identified by comparing these figures with the preexisting data. [5]

A face recognition-based attendance system was employed by Komal Saxena et al. with the goal of replacing manual procedures and enhancing the precision of attendance tracking. The system effectively recognises pupils using facial identification algorithms such as Viola and Jones. [6]

Anupama Menon et. al. developed an AI-based student monitoring system that includes features like visualization modules for attendance data and email notifications to students and parents when attendance falls below a certain level. The system incorporates machine learning algorithms for face recognition and attendance analysis. [7]

Setia Budi et. al. created an inexpensive method of keeping track of student attendance. Students can register their attendance by simply identifying their faces on the records, which are automatically generated using a face detection technology. Attendance is documented on class pictures. [8]

Mubarak Salem Mubarak Alburaiki et. al. suggested a framework that covered the following three key areas: First, use the cameras on mobile phones for automatic face detection and analysis. Second, a machine learning method is used by the facial recognition API. Maps API comes in third. More than thirty pupils have participated in a testing process aimed at determining how well the system recognises the faces and places of students. [9]

Azhaguraj.R. et.al. proposed an automated attendance control machine. The notion of transitioning from a traditional attendance method to virtual face recognition and identification techniques through the application of device learning algorithms has been deliberated. [10]

The authors highlight the necessity of creating unique models tailored to certain applications, which served as inspiration for their innovative CNN architecture for facial recognition. The proposed CNN architecture offers 99% accuracy, as shown by the experimental study reported in the paper. [11]

K. Vignesh and colleagues concentrated on creating a Convolutional Neural Network (CNN)-based facial recognition attendance management system. Their system also incorporates Open CV face recognition for image processing and attendance recording in an Excel spreadsheet. [12]

Kittipong Tapyou and the group used Raspberry Pi and Internet of Things devices to implement the HAAR Cascade and EBGM techniques. The quantity of faces or users in the system has no effect on the accuracy or distance. The range of average detecting distances was 306.68 cm to 416.67 cm, contingent upon the quantity of face photos utilised during the training phase. [13]

The main study reveals that the majority of algorithms like HAAR cascade, and Open CV were used to recognize faces: CNN and dlib to match the features of faces with accuracies such as 99%,99.38%, etc. The attendance was marked into CSV files, Excel sheets, and dashboards.

Some gaps were observed in the key research such as the deep learning models that give results that are more accurate than the models used in research. The attendance data was stored in CSV files and Excel files, but an SQL database can be used which occupies less space. The previous works available are not able to recognise the face in low lighting conditions, different facial expressions, and occlusions (e.g., students wearing specs). In this work, we are using advanced deep learning models, and SQLite database to improve the model's performance compared to the previous work.

3 PROPOSED MODEL

A systematic approach has been developed for the face attendance system as shown in Figure 1.

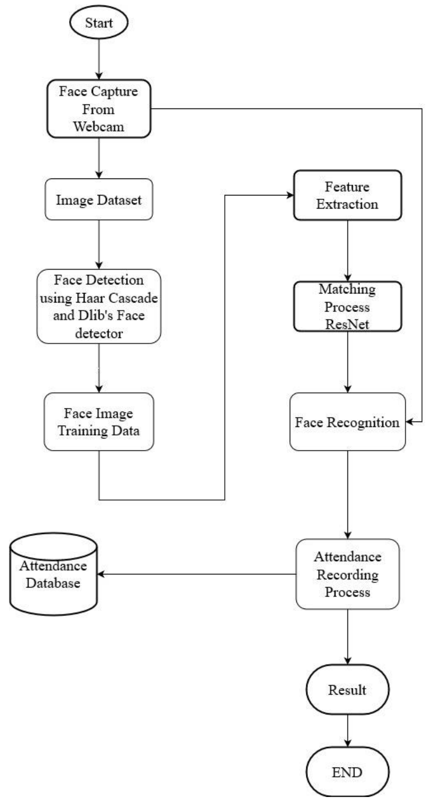

Figure 1: The Proposed Model's Workflow

3.1 Face Capture from Webcam:

Using the webcam the face capture happens and will be kept in the database. The photo that is taken will have a resolution of 358 x 358. These photos are used to store in the dataset.

3.2 Image Dataset:

For each person separate folders are created, and images are placed in that folder created for the person. Other images in the .jpg format also can be placed in the folder where the captured faces from the webcam are stored. These images are further used for preprocessing.

3.3 Face Detection:

Once the dataset is created, the captured images are processed. The dlib frontal face detector use the Haar cascade technique to locate the face region, which is then used to locate the 68 facial landmarks on the faces. The 68 landmarks that have been detected are shown in Figure2.[14] and fig.3 shows the land marks located on the face.

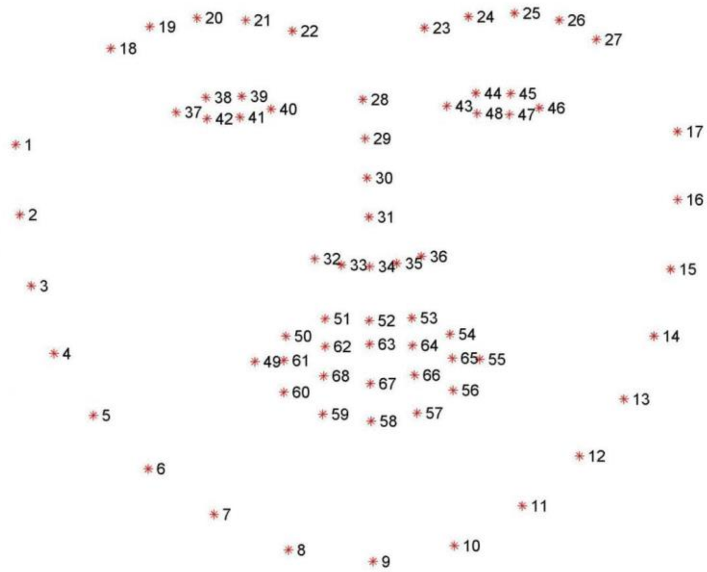

Figure 2: Locations of the Landmarks.[15]

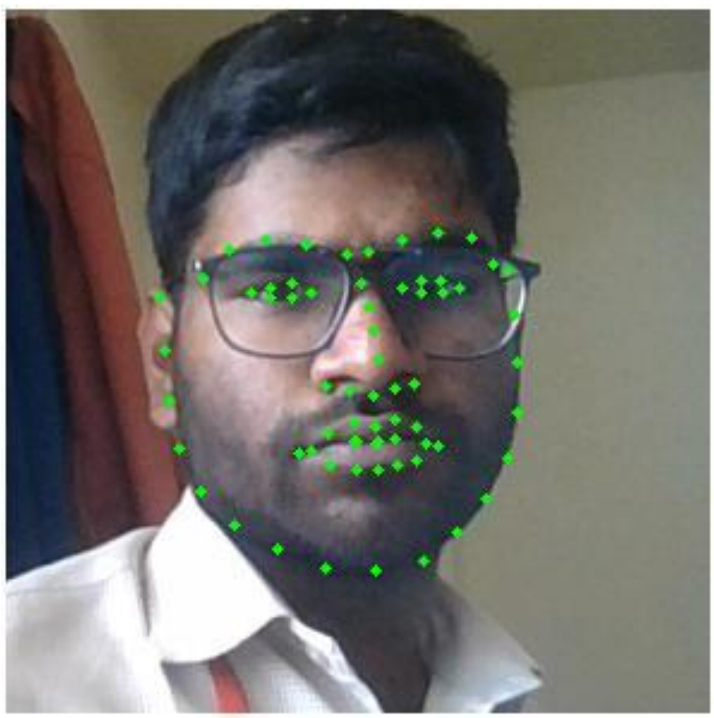

Figure 3: A face's landmark locations.

3.4 Face Image Training data:

The landmarks that are extracted from the face regions that the Haar cascade algorithm detects are saved as training data for the Resnet model and are subsequently utilised for feature extraction.

3.5 Feature Extraction:

Using the ResNet algorithm first the features are extracted. The features extracted are the 128 unique face discriminators and these features are stored in a CSV file.

3.6 Matching Process:

Using the 128 face discriminators and face region extracted the ResNet model is trained. The ResNet model has 50 layers. One global average pooling layer, sixteen residual blocks (each comprising several convolutional layers), one fully connected layer, and one initial convolutional layer are among them. [16][17]

3.7 Attendance Recording Process:

The Haar cascade technique is once more used to recognise the face region of the camera-captured image. After that, the attendance is recorded, and the face is matched using the 128 face discriminators.

3.8 Attendance Database:

The attendance recorded in every class is stored in the SQLite database and to view the attendance of the date a user-friendly webpage has been created.

4 EVALUATION MEASURES

For evaluating the performance of the model confusion matrix is used. The number of faces that the trained model properly predicts is displayed as a true positive (TP). The number of faces that the model predicts as unknown and for which it has not been trained is displayed by the true negative (TN). The number of faces that the model predicts to be a face that is not in the dataset is known as a false positive (FP). False negative (FN) is the No.of faces that the model is not predicting the face that is available in the dataset.

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \qquad (1)$$

$$Precision = \frac{TP}{TP+FP} \qquad (2)$$

$$Recall = \frac{TP}{TP+FN} \qquad (3)$$

5 IMPLEMENTATION AND RESULTS

For the implementation of this attendance system, Python 3 has been used. First, the dataset has to be prepared. To prepare the dataset faces are captured using the web camera. In Figure 4 we can see a red rectangle as the face is not in range to find the landmarks so we cannot capture the image that is out of range. The faces that are within the range can be captured and saved as shown in Figure 5. Additionally, it enables users to clear old face data and add new faces.

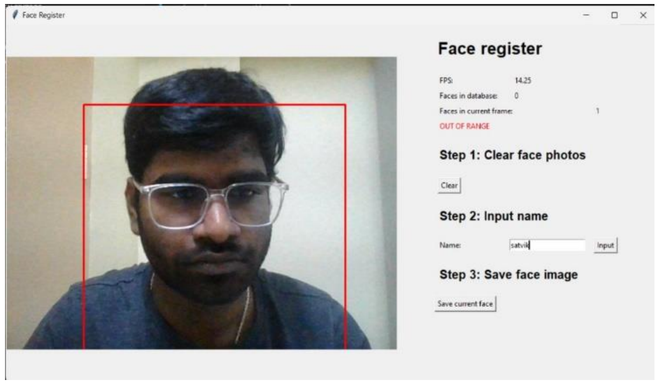

Figure 4: Face Capture from web camera.

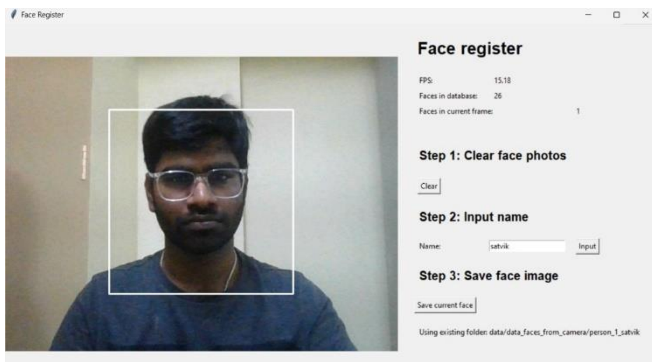

Figure 5: Saving the captured face to a predetermined location.

Table 1: Features Extracted

EAC21044	0.26019	0.1368	…	0.06647	-0.057
EAC21071	0.19541	0.1293	…	0.09931	0.0403
EAC21046	0.15161	0.1302	…	0.08106	-0.045
EAC21031	0.14779	0.1961	…	-0.0423	0.0104
EAC21053	0.25749	0.1240	…	0.08554	0.0174
……….	……..	……….	…	……….	……
EAC21040	0.20974	0.1140	…	0.11541	0.0510
EAC21080	0.27464	0.1174	…	0.1157	-0.035
EAC21030	0.22771	0.1371	…	-0.0200	-0.079
ECE21189	0.25036	0.1495	…	0.1012	-0.019

After the creation of the data the 68 landmarks of the face are found, and these are given as the input for the ResNet algorithm for extracting the features. As shown in Table.1 the 128 unique face-discriminating features are extracted and stored in the CSV file. The feature extraction is done by the convolutional layers that are present in the ResNet model. The features are generated by convolving the input images with learnable filters. These features are used to train the ResNet model. After the feature extraction, the model is trained and saved. Now the faces are given as the input for the system to mark the attendance. As shown in Figure 6 the face is recognized and the attendance is marked for that person. This model is also able to recognize the face under occlusion (a person without specs) as shown in Figure 7.

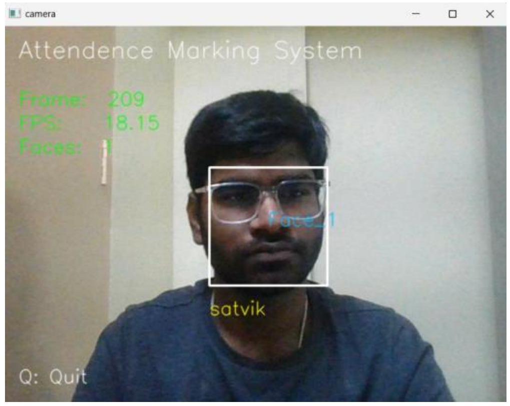

Figure 6: Face recognition.

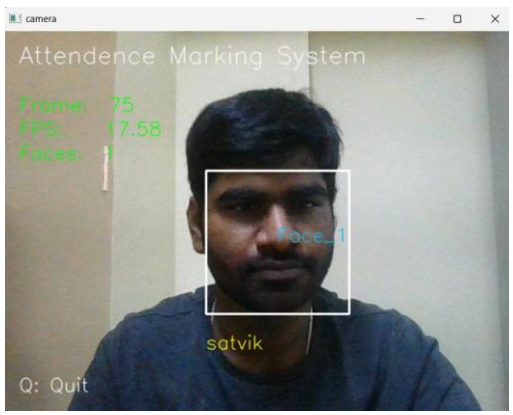

Figure 7:Face recognition with occlusions.

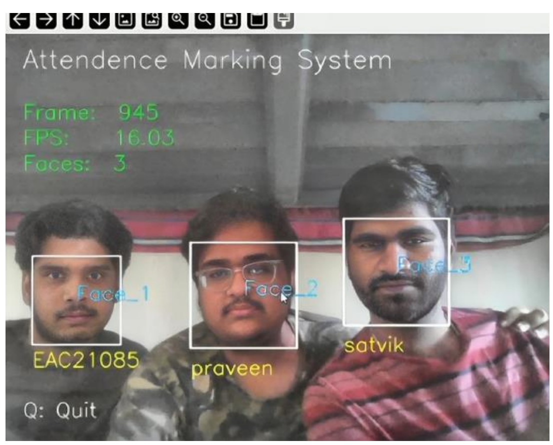

Figure 8: Face recognition with multiple people.

The model will also recognize the multiple faces as shown in Figure 8. It will mark the attendance of multiple people at the same time. Rather than capturing the faces from the camera, this model will also enable the user to give video input for marking the attendance. A Flask web application is developed to display attendance data stored in an SQLite database. It defines two routes: '/attendance' to handle form submission and retrieve attendance data based on selected date, and '/' to render the main page with a date selection form. In order to retrieve attendance records for the chosen day, the script establishes a connection with the database and runs a SQL query. As shown in Figure 9& 10 the administrators can view the attendance report of any date.

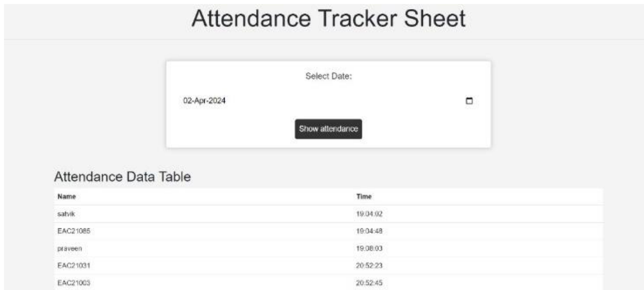

Figure 9: Attendance Report on 2nd April 2024.

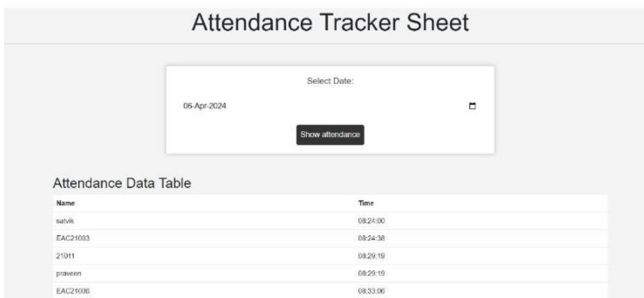

Figure 10: Attendance Report on 6th April 2024.

6 CONCLUSION AND FUTURE SCOPE

The suggested system automates the process of marking attendance using facial recognition. Using image processing algorithms from Dlib and OpenCV, the system detects faces, recognises individuals, and marks their attendance in real-time. Dlib's face detection and recognition models provide robust capabilities for detecting faces, predicting facial landmarks, and computing face descriptors. These features enable the system to accurately identify and differentiate known individuals from unknown faces in real-time video streams. Additionally, the integration with an SQLite database allows the system to store attendance records securely, associating each entry with the date, time, and name of the recognized individual. Attendance tracking system is provided with a database-driven outlook which enables the administrators to create reports and analyse attendance report efficiently.

Further improvements can be made using algorithms like Kalman Filtering or object tracking algorithms which can be used to track multiple faces. Fundamentally, efforts will be put towards improving the accuracy of facial recognition algorithms and making sure more reliable identification of individuals. Moreover, the implementation of real-time analytics will help administrators to acquire important perception into attendance record. To improve the security measures systems with access controls can be integrated, allowing for smooth access management. Moreover, convenient and easy access to the attendance system can be provided to the user by developing a mobile application which enables remote attendance. Lastly, the system's adaptability to a growing database and reliability can be ensured by integrating cloud integration and scalability.

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